



Air Monitor P570

A Cultural, Spiritual and Health Impact Assessment

Of Oil Drilling Operations in the Navajo Nation area of
Counselor, Torreon and Ojo Encino Chapters

January 15, 2020

Prepared by the Counselor Health Impact Assessment - Hozhogo'na'ada Committee

Counselor Health Impact Assessment (HIA) - Hozhogo'na'ada (HNDA) Committee

Principal Investigator

David Tsosie, Ed.D. (Diné Centered Research & Evaluation)

Co-Principal Investigators

Valory Wangler, M.D. (HIA)

Herbert Benally, Ph.D. (HNDA)

Authors

HIA

Teresa Seamster, M.S., Ed.S

Sujit Joginpally M.D., M.B.A (SW Pennsylvania Environmental Health Project)

Celia Lewis, Ph.D (SW Pennsylvania Environmental Health Project)

Brandon Velivis, M.P.S. candidate (GIS mapping)

HNDA

Herbert Benally, Ph.D.

Moroni Benally, MPP, MSPPA

Committee

Daniel Tso, Counselor Health Committee Chair, Navajo Tribal Council Delegate

Samuel Sage, Counselor Chapter Community Services Coordinator

Marlene Thomas, Counselor Chapter Health Representative

Kendra Pinto, Counselor Chapter Air Quality Coordinator

Mario Atencio, Board Member, Diné C.A.R.E.

Carol Davis, Director, Diné C.A.R.E.

Hazel James, San Juan Collaborative for Health Equity

Robert Tohe, Our Wild America

Miya King-Flaherty, M.S., Our Wild America

Sonia Grant, Ph.D. Candidate

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Bridging the Cultural, Spiritual and Health Impacts of Oil Drilling

David Tsosie, Ed.D.

The Holy Surface Earth People (Diné) have always tried to follow the many traditional teachings that have been shared with them by the Holy People since time immemorial. These teachings have been passed down from one generation to another and have for centuries established the parameters for the relationship that has been maintained by the Diné people. Our elders tell about the stories of the creation when the Holy People came into the White World/Glittering World. They placed the sacred mountains, the rivers, the plants, the animals, the birds, and all life forms in their proper places and environment. They ordained, through songs and prayers, the earth and universe to embody Nitsahakees (thinking), the water and the sacred mountains to embody Nahata (planning), the air and vegetation to embody Iina' (life), the fire, light, and offering sites of variegated sacred stones to embody Sihasin (wisdom). These became the fundamental tenets established to follow an order of thinking, being the foundation of planning, and life, being the foundation of wisdom. These tenets became an integral part of our life pattern where all important events have first to be thought out, then planned, then they all become part of life process, and from here, wisdom is attained to guide the future generation.

More importantly, the Diné Traditional Law mandates that the teachers of traditional laws, values and principles must be respected and honored if the people and the government are to persevere and thrive and that their participation and contributions of the traditional values and principles of Diné life way will ensure growth of the Navajo Nation. Additionally, the Diné Natural Law emphasizes that:

1. The four sacred elements of life, air, light/fire, water and earth/pollen in all forms must be respected, honored and protected for they sustain life;
2. All creation, from Mother Earth and Father Sky to the animals, those who live in water, those who fly, and plant life have their own laws and rights to exist; and
3. We, the Diné, have a sacred obligation and duty to respect, preserve and protect all that was provided for us and that we were designated as the steward of these relatives and must acknowledge them thorough our use of the sacred gifts of language and thinking.

It is important to note that Mother Earth and Father Sky are part of us as Diné and we are part of Mother Earth and Father Sky; thus, we must treat this sacred bond with love and respect without exerting dominance. The love, respect and honor that is shown to our natural environment is displayed by following the proper protocols of making offerings at sacred sites requesting permission to only take what is needed and to place them back with prayers and songs.

There are ceremonial stories of how many of these elements were placed into the earth and sky to be part of the cosmic order. If they were excessively removed, there would be devastating consequences. One story tells of the destruction of the monsters and evil forces that came upon the people after they came into the Glittering World. Monster Slayer and Born for the Water

brought about the destruction of all the evil forces/energies that were annihilating the people living in the Glittering World. After all of these evil forces were destroyed, they were placed into the earth and sky and it was declared that they should never be disturbed.

After the obliteration of the evil forces, the people lived in a peaceful environment for a long time. One day some of the people noticed a change in the environment and called on the Holy People for guidance. The Holy People discussed the situation and asked the Early Twilight Dawn deity to assist in correcting the disharmony that had come into the environment. To restore order and harmony, the Twilight Dawn deity gathered all of the sacred mineral people at Dziil Na oodilii (El Huerfano). After much discussion, it was decided to send all of the mineral people into the earth to restore order and become caretakers. It was then agreed among the Holy People that minerals can only be taken out of the earth with prayers, songs, and offerings. After their use, minerals will be placed back into the earth with prayers, songs and offerings. There would be devastating consequences if large quantities of minerals were taken out of the earth without following the proper protocols.

We have seen these devastating effects in how they have brought certain health complications and illness like cancer, respiratory problems, and other sicknesses among our people. Under the leadership of the late Dr. Larry Emerson, a study titled Hazho Nadaii was started to examine problems and issues through a Diné Lens, meaning looking at problems and issues by incorporating Diné traditional stories and teachings to address how some of these complications could be dealt with. It was through this initiative that the Counselor Health Impact Assessment - Hozhogo'na'ada Committee started looking at the concerns of communities around oil drilling activities and the use of fracking to acquire more oil. We undertook a two-phase approach to looking at the problem oil drilling operation in the three Chapters of Counselor, Torreon, and Ojo Encino (the Tri-Chapter).

Since 2015, the residents of Counselor Chapter have voiced concerns about sudden and unusual health symptoms experienced from breathing polluted air around oil wells near their homes and roads. The Chapter communicated those concerns in a 2015 Resolution to the Navajo Tribal Council and requested a Health Impact Assessment (HIA) be conducted before further oil operations were permitted. In January 2018, the Navajo Nation Human Research Board approved a two-part Health Impact Assessment: Part One - to conduct air sampling and voluntary health surveys in Counselor Chapter, and Part Two - Hozhogo'na'ada - the continuation of Hazho Nadaii - a traditional survey taken by residents from Counselor and two neighboring chapters, Ojo Encino and Torreon.

The first phase of the Health Impact Assessment (HIA) examines the changes that intensive oil drilling has made to the air quality of Counselor Chapter, and identifies related health symptoms reported by chapter residents.

The second phase of the Assessment, Hozhogo'na'ada (HNDA) is a survey tool and model that seeks to identify degrees of concern felt by the individual regarding the familial, community, cultural, and environmental impacts from current oil drilling and the threat of expanded land leasing facing these three Diné communities.

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I. Introduction - Is the Open Air Safe?

Counselor Chapter is a rural, sparsely populated, high desert area, with tree-covered mesas and pinion-juniper forests and grasslands. There are an estimated 700 residents and many live in small familial clusters in the Cross Roads and Cornfields areas in the central area of the Chapter. The Chapter House, Lybrook Community School, and the Lybrook Ministries are located on the Chapter's northern boundary of US Highway 550, approximately 35 miles north of Cuba. The northern half of the 70,771-acre chapter is a heavily developed gas and oil area with more than 400 oil wells, industrial wastewater ponds, storage tanks, pipeline infrastructure, and a network of dirt access roads for oil company workers across the community.



For over five years, Counselor leaders and residents have reported their concerns to tribal, state and federal agencies and taken actions to identify the multiple impacts of this industrial development within the community. A young father-to-be spoke at a Chapter meeting on May 23, 2016 with these words: "How is our younger generation going to survive? Is the open air going to be safe? Will it cause birth defects or not?" This report attempts to answer these questions and many others, and to reveal how little is yet known about oil development's ultimate impacts on human health and the environment.

Points to bear in mind regarding local impacts of well emissions:

- Emissions from over 400 gas and oil drilling sites in Counselor Chapter are significantly increasing the reported respiratory health symptoms of residents that mirrors results of national health studies.
- Continued and cumulative exposure to elevated levels of toxic gases, particularly formaldehyde, from nearby well operations can lead to chronic respiratory effects and cancer¹.
- Lease sales for oil development are proposed in the adjacent chapters of Torreon and Ojo Encino raising concerns that similar health, safety and cultural impacts will be felt in those communities.
- Exposures to emissions do not occur evenly over time, but spike in intensity periodically.
- The extent to which people are exposed to toxins is determined by the concentrations of emissions vented and leaked, combined with weather conditions.
- There is now an abundance of information about shale gas and oil site emissions and their potential to do harm to the health of residents who live within 5 miles of well operations, but almost no data on the Checkerboard Area of the Navajo Nation.

¹ Southwest Pennsylvania Environmental Health Project Report: "Counselor Chapter Air Quality Assessment Results: Particulate Matter (PM2.5) and Volatile Organic Compounds (VOCs)", August 3, 2018

Getting Started: Health Impact Assessment Checklist

Free, Prior and Informed Consent: Have Counselor residents been provided the information they need by state, tribal or federal agencies before leasing their land for gas and oil development?

	NOT PROVIDED	INCOMPLETELY ADDRESSED	ADDRESSED WELL
Attention to concerns of residents		X BLM-BIA meetings w/ no explanation of potential harms or permanent effects	
Listing of chemicals emitted and at what concentrations	X Not Provided		
How often will emissions occur and at what times of day	X Not Provided		
Projected exposure within a mile of site – daytime and nighttime at peak level	X Not Provided		
Radioactive material present	X Not Provided		
Air monitoring plan specified			X Counselor HIA Monitoring Project w/ EHP
Warning system in place for times of planned or unplanned high releases for those within a mile	X WPX explosion and 5 day fire (July 2016) is one of many examples of need for evacuation plan/response		
Blowdown emissions addressed	X Not Provided		
Emissions from flares estimated	X Not Provided		
Sufficient distance from schools, day cares and other sensitive locations	X Lybrook School has 31+ wells located within 2 miles of the property		
HEALTH IMPACTS			
Chronic and episodic exposure effects on children addressed	X Not Provided		
Exposure effects on fetal development addressed	X Not Provided		
Effects of PM2.5 addressed			X Counselor HIA monitoring w/ EHP analysis
Effects of VOCs addressed			X Counselor HIA Monitoring w/ EHP analysis

QUESTIONS OFFICIALS OUGHT TO ANSWER BEFORE GOING FORWARD WITH SHALE GAS OR OIL DECISIONS IN NEW MEXICO

Public agencies - Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), Navajo Nation EPA, NM Energy, Minerals & Natural Resources Department - at the federal, tribal, and state level - should address the health concerns raised in this report and establish Conditions of Approval or prohibit certain industrial operations in inhabited areas to protect the public from harm. In order to protect public health, it is necessary to know whether dangerous levels in pollutants will occur in a developing area and what health effects may occur in the short or long-term.

This Health Impact Assessment helps organize information needed to start answering critical questions:

1) What chemicals are being emitted or leaked? 2) Are people being exposed to harmful levels of emissions? 3) What is the local air quality? 4) What health effects from chemical exposures have been determined? 5) How can your agency mitigate or remove existing or potential harms?

II. Chemical Exposure in Counselor

The complete list of chemicals being used in oil drilling operations in Counselor is unknown. Of the 75 toxic substances tested for in four 24-hour samples, a total of 8 toxic chemicals were detected. Results (Appendix 2) found formaldehyde at 4 sites, at elevated levels (greater than 0.003 ppm) that carry recommended actions to reduce exposure for local residents. Other detected chemicals:

2-Propanol
Acetone
Chloromethane
Dichlorodifluoromethane
Hexane
Methylene chloride
Trichloroethene

Certain classes of particles and chemical agents have well known health effects that have been documented by the Occupational Safety and Health Administration (OSHA), American Cancer Society, Agency for Toxic Substances & Disease Registry (ATSDR) and in scientific journals, medical reports, clinical studies and media articles².

The presence of these chemicals makes it likely that other commonly used chemicals at well sites are present at different stages of operations.

² "Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking" (5th Ed., 2017) Physicians for Social Responsibility, Concerned Health Professionals of NY.

Chemicals Detected, Methods of Exposure and Associated Symptoms

2-Propanol – Inhalation; exposure can cause headache, dizziness, nausea, respiratory depression and coma. (Highly flammable)

https://www.google.com/search?source=hp&ei=qw49XKyHKO2_jgT7kIf4Bw&q=2-propanol+hazards&oq=2-&gs_l

Acetone – Inhalation; exposure can irritate eyes, nose and throat, and cause dry, red, cracked skin. (Highly flammable) https://www.ccohs.ca/oshanswers/chemicals/chem_profiles/acetone.html

Chloromethane & Dichlorofluoromethane – Skin contact: exposure can cause severe irritation and chemical burns to eyes.

<https://www.msdsolnline.com/2015/02/20/dichloromethane-methylene-chloride-hazards-safety-information/>

Hexane – Inhalation: short-term exposure affects the nervous system and causes headaches, dizziness and nausea. Chronic exposure can lead to severe damage to the nervous system, dermatitis and irritation of the eyes and throat. (Solvent)

<https://www.msdsolnline.com/2014/11/19/understanding-the-hazards-of-hexane/>

Methylene chloride – Inhalation and Skin contact: exposure may cause mental confusion, dizziness, nausea, and headache. Continued exposure can cause eye and respiratory irritation. Skin contact may cause irritation or chemical burns. (Solvent)

<https://www.osha.gov/Publications/OSHA3144.html>

Trichloroethylene (TCE) – BANNED in food and pharmaceutical industry since 1980s - Skin contact: exposure may cause fetal toxicity and causes effects on the nervous system related to hearing, seeing, balance and heartbeat, also liver and kidney damage. (Non-flammable)

<https://www.edf.org/health/banning-high-risk-uses-trichloroethylene-tce>

Formaldehyde – Inhalation: exposure can cause cough, sore throat, nosebleeds and eye irritation. It can cause cancer of the nose and throat and is harmful for people with asthma, bronchitis or other breathing conditions.

<https://www.cancer.org/cancer/cancer-causes/formaldehyde.html>

Facilities of Concern

Gas & Oil Wells & Pipelines (Components & Maintenance using solvents and flammables):

- Tanks, pipelines, equipment and other quantifiable descriptions of pollution sources on well pads, including amount of gas moved through pipelines, type of engines, horsepower of engines, pipeline pressure, diameter of pipeline, and any safety procedures followed: **Not described to public**
- Mobile tankers and wastewater on site that have potential to contaminate area: **Not described to public**

Table 1. Counselor Land Use within 1/2 mile to 1-mile radius of gas and oil wells

Parcel Category	1/2 Mile Radius	1 Mile Radius
Grazing Land	X	
Residential	X	
Health Clinic	X	
Public Water well		X
Church	X	
Ministry complex	X	
Oil Refinery	X	

Setbacks

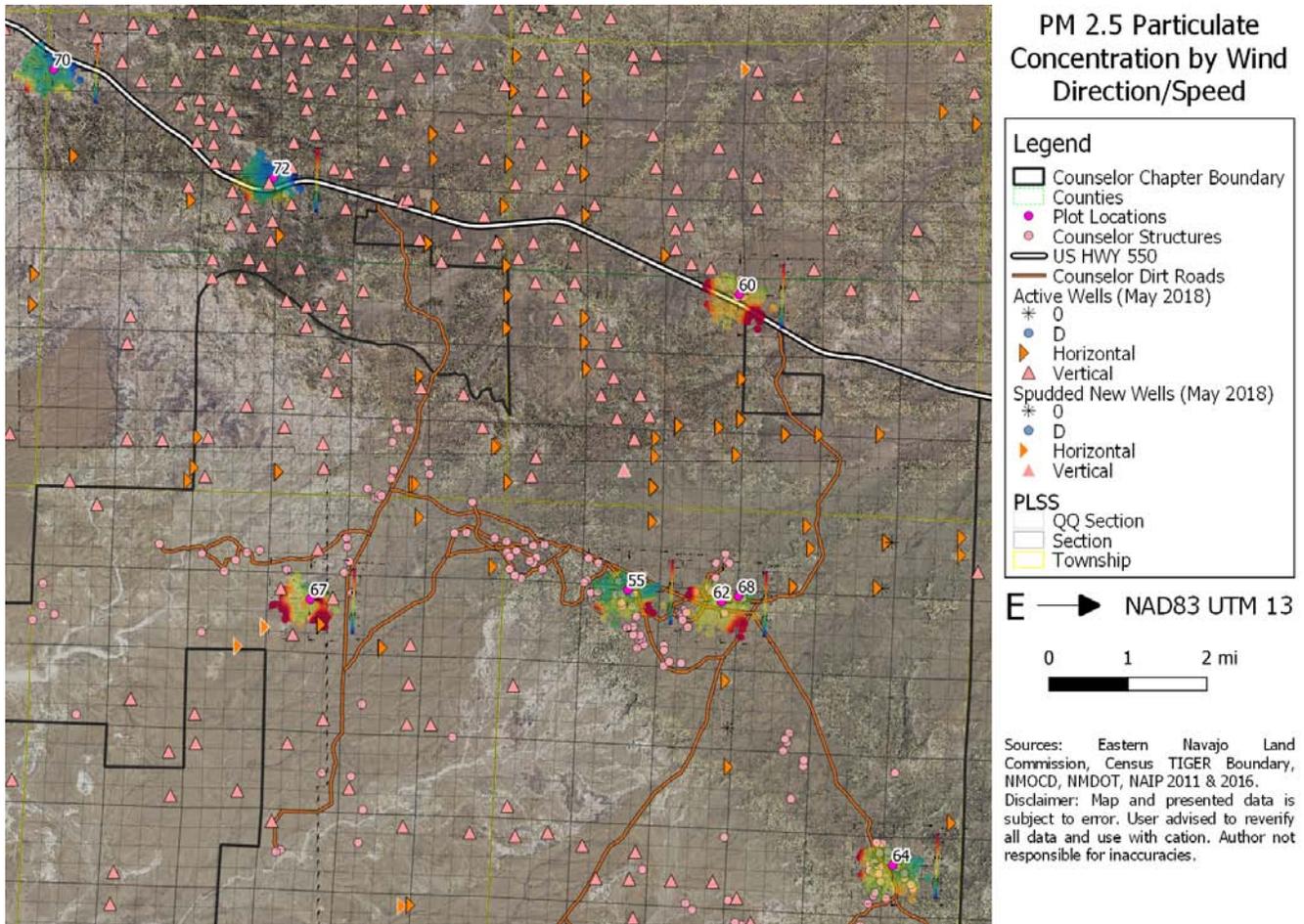


Figure 1: Map of Structures in Counselor NM showing oil wells and 8 air monitor sites

Gas and oil wells are in close proximity to residences and other structures in the areas leased for development. There is no fixed setback distance from well pad to residential structure, school, or business. Setbacks vary from 330 feet (or less if the well is an older vertical well) to 660 feet. The majority of the 700 residents in Counselor live within 1 mile of one or more wells, pipelines, and/or

other gas and oil infrastructure. Colorado now requires a 1000' setback while medical professionals have estimated that a “diluted dose” of continuous emissions is attained with a residential setback of 6,600'³ from large well sites, compressor stations, storage areas or processing plants.



Photo by Teresa Seamster

Figure 2: Partially developed area near Heart Mesa (near Cross Roads) leased for future oil drilling.

Residents are concerned about drilling on lands within the chapter that have not been developed before. New pollution sources have significant cumulative impacts on residents. Additional gas and oil wells will add to whatever air pollution is already present. Each permit to drill additional wells should be evaluated by what it *adds* to current impacts on local air quality, not only what emissions it produces itself.

New Mexico Gas and Oil Emissions Inventory show High NO_x and S₂O Levels

A national oil and gas inventory by ENVIRON for 2018 was estimated by growing the 2002 inventory using factors derived from resource management plans produced by the Bureau of Land Management and regional forecasts made by the Energy Information Administration. Methodologies were developed that could be applied consistently across the western region, without overlooking the variability in local production characteristics, control requirements and inventory thresholds. Application of these methodologies resulted in the addition of almost 120,000 tons of NO_x emissions to the 2002 Western Regional Air Partnership (WRAP) emission inventory. New spatial surrogates were generated based on well locations to appropriately distribute these emissions.

Additional effort was made to estimate emissions in new development areas without base year emissions. The resulting approach incorporated the most complete information available on the anticipated oil and gas development in the western US region to produce an inventory that predicts a doubling of non-point oil and gas NO_x emissions between 2002 and 2018. Emissions for each formation were calculated as the product of the formation specific emission factor and the number of wells drilled in the formation in 2002. The emissions for that formation were then allocated to the

³ www.environmentalhealthproject.org (Recommendations for Mitigation of UOGD to Protect Public Health)

counties that intersected the formation based on the fraction of the wells drilled that were drilled in each county's portion of the formation.

The state total drill rig NOx and SO2 emissions that resulted from this procedure are shown in Table 2. The adjustments made to the emission factors are apparent in these results. While significantly more wells were drilled in the State of Wyoming than in New Mexico, the emissions in New Mexico are higher than in Wyoming. This occurs because many of the Wyoming wells were drilled quickly and to a shallow depth, as commonly occurs for the Powder River Basin CBM wells. In contrast, the wells in New Mexico were, on average, drilled deeper and took longer to drill. (See Western Regional Air Partnership Technical Support System <https://views.cira.colostate.edu/tss/Results/Emissions.aspx>).

Table 2. State total drill rig emissions.

State	Wells Drilled	NOx (tons)	SO2 (tons)
New Mexico	932	6,645	1,444
Total in US:	6,088	21,536	3,706

New Mexico has drilled slightly > than 15% of the total US rigs and generates > 30% of the Nitrogen Oxide emissions and almost 39% of the Sulfur Dioxide emissions for the US.

Sulfur Dioxide (SO2): Levels of this emission are not routinely reported to the public or highlighted as a health risk in publicly available county air quality or health statistics. At high concentrations SO2 can cause life-threatening accumulation of fluid in the lungs (pulmonary edema). Symptoms caused by lower concentrations may include coughing, shortness of breath, difficult breathing and tightness in the chest. A single exposure to a high concentration can cause a long-lasting condition like asthma.⁴

III. Harmful Emissions

Current Regional Air Quality

2018 American Lung Association AQI Report:

San Juan County - High Ozone Days: Grade C

San Juan County - Particulate Matter Pollution: INC (incomplete state monitoring for PM)

San Juan County - Groups at risk (Lung Cancer, COPD, Asthma, etc)

Navajo Nation Environmental Protection Agency (NNEPA) Air Quality Control Program conducted air monitoring of measured criteria air pollutant levels in Counselor from April 14, 2016 to May 18, 2017. Data were downloaded monthly and quality checks (QC) done on the gaseous analyzers and particulate sampler. The observed 1-hour NO₂ and SO₂ did not exceed primary NAAQS; observed 8-

⁴ See EPA Integrated Risk Information System: <https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#effects>

hour maximum O₂ and daily 24-hr. PM₁₀ did not exceed NAAQS, with generally good to moderate readings. (See Appendix 3) Note: No comparisons were made with other locations in the chapter nor were monitoring distances from active wells reported.

Average and High Periods of Exposure in Counselor

Many of the chemicals released at gas and oil wells can have respiratory effects and increase asthma rates for adults and children. Some chemicals emitted can affect reproduction and infant mortality and disabilities. The National Environmental Public Health Tracking Network: (<https://www.cdc.gov/nceh/tracking/>).

Exposures from gas and oil wells are not constant. There are several variable contributors to individual exposure:

- 1) Emissions at any given time – There will be more emissions during a time when a large amount of gas is being vented or going through the pipeline as compared to when little or no gas is.
- 2) Content of the emissions – The content of the emissions also varies by the area of shale that the gas was released from. For instance, some gas may have more Hydrogen Sulfide than others; other sources may have more Radon or Radium.
- 3) Weather conditions – The weather (temperature, wind, and cloud cover) will affect whether a well's emissions will disperse quickly away or whether it will stay in close proximity.
- 4) Topography – The topography will affect how much emissions exposure a home might receive. Counselor has many mesas and arroyo areas that can either block air currents from home sites or trap air contaminants around residences for periods of time. Large flat open areas predominate the area and strong winds can quickly carry toxins from well sites to occupied structures before they have a chance to rise or mix with the air to become less hazardous. Some of the most polluted air has been found in these open areas.



Photo by Teresa Seamster

Figure 3: Winter flaring (2018) near Corn Fields residential area in Counselor

Exposures vary over time; even varying from one half-hour to the next. If you average the exposure level over the year or month or day, you will miss the high (and more dangerous) periods of exposure. For instance, over a **24-hour period the average particulate exposure was 29 ug/m³** but there was a period just before dawn that was **398 ug/m³** that was high enough to cause an asthma attack.

IV. Counselor Chapter Air Monitoring Results (2018)

The Counselor HIA Committee, under the guidance of the Environmental Health Project (EHP), conducted community air quality monitoring in the spring of 2018. Data were collected from eight indoor and outdoor residential and public locations in Counselor from mid-April to the end of May. These results have been compared to other results that EHP has reviewed in communities near shale gas and oil operations in New York, Ohio, California and Pennsylvania. (Note: Indoor results were reported to the residents living at the 8 locations and are not part of this community report.)

Outdoor Speck monitors were deployed during the week of April 8 to April 15 and were located an average of 30' to 50' away from the side of the house closest to the nearest oil well. All monitors were retrieved between 32 to 45 days later and sent to the Environmental Health Project in New Haven, Connecticut, for data analysis.

The analysis found that large-scale changes (peaks) in air quality averaged 2-4 peaks per day and lasted from 21-28 minutes per peak exposure. The time between peaks varied from 6 to 13 hours while the median for other communities sampled by EHP is 8.5 hours. The level of particles generally found outside between peak times was considerably higher in six locations compared to the median found in other communities, and the total sum of accumulated particle counts over the 32-day period was at or above average levels of accumulated fine particulate matter (PM_{2.5}) in other sampled communities nationally. With higher than average PM_{2.5} levels, residents living near a source of air pollution are at greater risk for developing or worsening respiratory or cardiovascular diseases. Further, some air contaminants cause neurological effects or are carcinogenic.

Outdoor PM 2.5 Results from 8 Counselor Residential sites

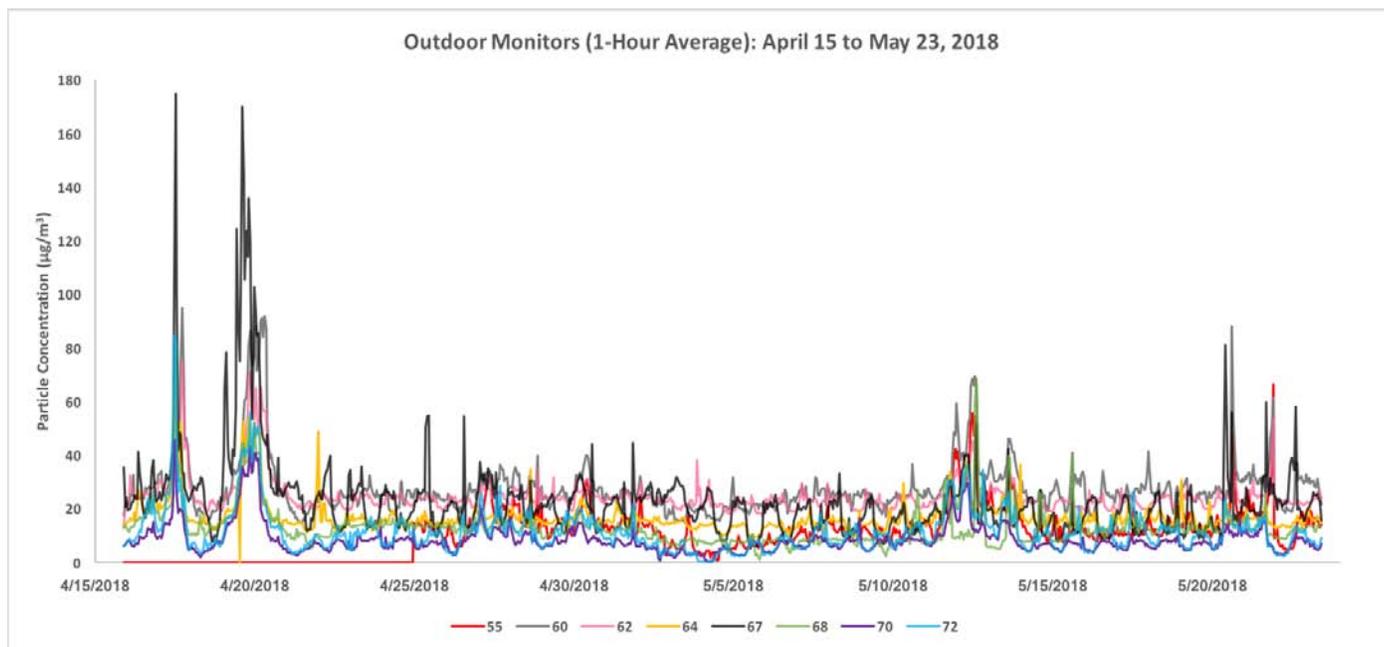


Figure 4: PM_{2.5} Results from 32-Day monitoring period. Monitor numbers correlate to colors.

Figure 4 shows the results from eight outdoor Speck monitors placed in the community for 32 days. Significantly, there were many times when peaks in PM_{2.5} (particulate matter in the air that are 2.5 microns in size) exposure occurred simultaneously at various locations, most notably on April 17, 2018 and April 19, 2018. When a source of air pollution is nearby, these conditions could cause increased exposure for residents. Chemicals from the source may combine with the particulate matter and travel to the deep regions of the lungs to cause respiratory problems or gain access to other parts of the body through blood-gas exchange.

Additional Outdoor Air Testing in Counselor

Volatile Organic Compounds (VOCs) samples were also collected at four of the eight Speck monitor sites. Sampling was conducted from May 29 to May 30, 2018 for a 24-hour period using four summa canisters and four sets of Radiello absorbing cartridges (hydrogen sulfide) and formaldehyde badges. The samples were tested for 75 chemicals. Three VOCs were detected on May 23, 2018 and seven on May 30, 2018. No Hydrogen Sulfide was detected but Formaldehyde was found at all locations. For all other chemicals identified there is a threshold to consider action. In this one sample, all chemicals were found at levels below what would cause immediate health concerns except Formaldehyde.

There are some 600 chemicals that can be used in the production of gas and oil, and sites can use different types of chemicals and combinations. However, there are several common pollutants such as VOCs, PM_{2.5}, and formaldehyde. EHP uses these 3 as “indicators” because scientists have measured and estimated the amounts of these chemicals emitted from oil/gas well sources. If these indicators are present in air samples, it is likely that other chemicals of concern are present.

Table 3: Elevated levels of Formaldehyde were found at all four locations

May 23, 2018	May 30, 2018
Acetone	2-Propanol
Chloromethane	Acetone
Dichlorodifluoromethane	Chloromethane
	Dichlorodifluoromethane
	Hexane
	Methylene chloride
All PEL- permissible exposure limits	Trichloroethene
	All PEL
Formaldehyde*	Formaldehyde*
0.0090 ppm	0.0070 - 0.0097 ppm
Take action at 0.003 ppm	Take action at 0.003 ppm

Previous Air Quality Testing in Counselor at Operational Well Sites

October 14, 2016

Two samples were collected at entrances to active wells along US 550 in Counselor and both showed levels of Toluene ((19 $\mu\text{g}/\text{m}^3$ and 72 $\mu\text{g}/\text{m}^3$). These levels are under relevant health-based standards (acute 8 hour chronic reference exposure level) however **these levels of Toluene are unusually high.**

A 2013 survey of air quality in more than 100 locations nationally found daily “mean concentrations” of Toluene lower than in Counselor ranging from 0.073 - 19 $\mu\text{g}/\text{m}^3$.

April 18, 2017

Three air samples were collected at entrances to active wells along US 550 at 1) mile marker 100 north of Lybrook School; 2) at mile marker 107.5 south of the San Juan and Rio Arriba County line; and 3) at the intersection of US 550 and County Road 7900. Hydrogen sulfide was detected at mile marker 100 closest to the Lybrook School at a level of **7.6 $\mu\text{g}/\text{m}^3$** . (See ALS Lab results in Appendix 1)

Hydrogen sulfide is a gas that has a potently offensive odor of rotten eggs and exposure to it is associated with an elevated incidence of respiratory infections, eye and nose irritation, coughing, breathlessness, nausea, headache, and mental symptoms including depression. The US EPA reference concentration level (RL) is **2 $\mu\text{g}/\text{m}^3$** .

The level detected exceeded the RL but was below the Office of Environmental Human Health (OEHHA) California chronic reference level for hydrogen sulfide. **But if levels of 7.6 $\mu\text{g}/\text{m}^3$ generally are reached then these levels can pose a human health risk for students and staff at Lybrook School.** (Additional analysis from Mark Cherniak, Ph.D., Staff Scientist, Environmental Law Alliance Worldwide)

EHP Analysis of Counselor Air Monitoring Results

After air-monitoring results were obtained, the Counselor HIA Committee consulted with Environmental Health Project specialists: Celia Lewis, Ph.D., and Sujit Joginpally, M.D.

1. How does Counselor compare with other communities being monitored by EHP?

Six (6) out of the eight (8) monitored locations in Counselor Chapter recorded levels between 10 to 25 micrograms/meter³, with only 2 locations reading at Baseline PM_{2.5} levels in other communities are generally below 10 micrograms/meter³. the lower average PM_{2.5} level. Also, the total particle count over the 32-day monitoring period was at or above average levels of accumulated PM_{2.5} for other states.

2. Are Counselor’s PM_{2.5} levels considered high?

Yes, because they are higher than average PM_{2.5} levels recorded at similar distances from oil wells in communities in New York, Ohio, California and Pennsylvania. Counselor is the first community in a southwestern state to be monitored by the Environmental Health Project.

3. What are some reasons for Counselor’s higher levels of PM 2.5 and Formaldehyde?

Many homes in Counselor are located closer than a mile to one or more operating oil and gas wells. The recommended setback distance between occupied structures and wells is now 6600’, or 1¼ mile. Many homes are “downwind” of wells that emit Volatile Organic Compounds (VOCs) and Formaldehyde (which can be formed from methane emissions in the presence of sunlight). Counselor has areas of open plains with numerous homes situated where the wind tends to blow towards the houses from a nearby pollution source. On sunny days with no wind, pollutants will rise quickly upward away from houses. On cloudy days with no wind, pollutants more slowly and mix with the air very slowly keeping emissions closer to the ground and more hazardous for residents. On windy days, pollutants from nearby wells can reach downwind homes nearby before chemicals can disperse.



Photo by Samuel Sage

Figure 5: Summa Canister monitoring Volatile Organic Chemicals (VOCs) at Counselor Chapter House in May 2018.

(See Appendix 2 for complete report: SWPA Environmental Health Project: Counselor Chapter)

EHP analyzed results for PM_{2.5} at eight residences/locations in the Counselor area. In the bar charts below, each **blue dot** represents the average results for outdoor air levels at one home. The **red bar** marks the average (median) of all results compiled by EHP outside New Mexico.

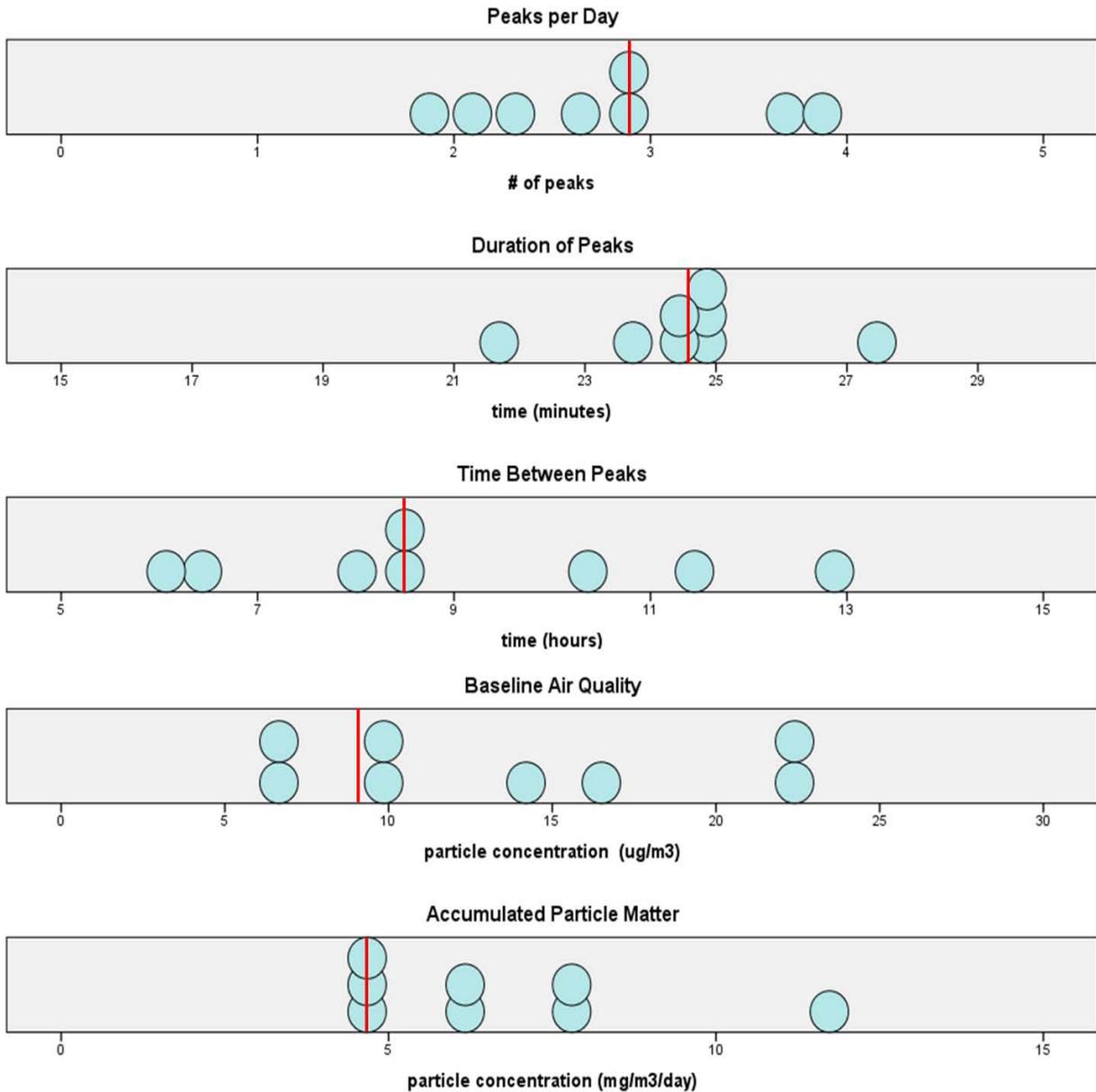


Figure 6: The range of results of PM_{2.5} monitoring for five components measured Peaks per day, Duration of peaks, Time between peaks, Baseline air quality and Accumulated particle matter using Speck monitor data.

The results are shown in relation to the national data reviewed to date by EHP. The majority of locations in Counselor had higher particle concentration (ug/m³) in their Baseline Air Quality and higher Accumulated Particle Matter (mg/m³/day) than in similar locations monitored in other states.

Comparisons of Wind Speed and Direction on Individual Site Air Pollution

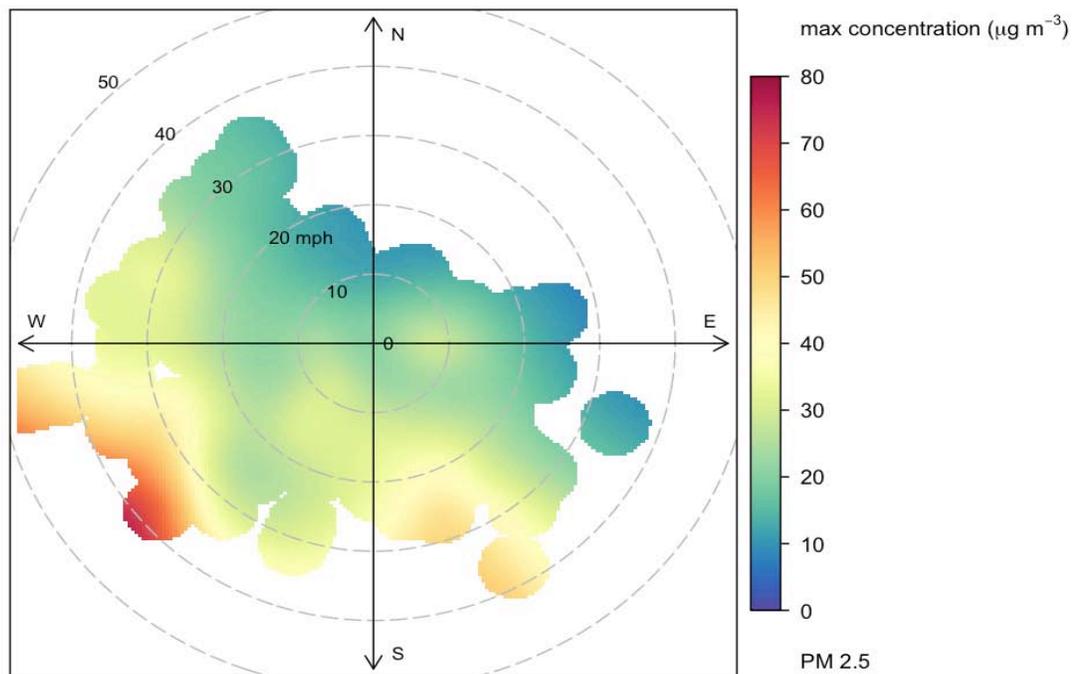


Figure 7: Counselor East (CE1) P568

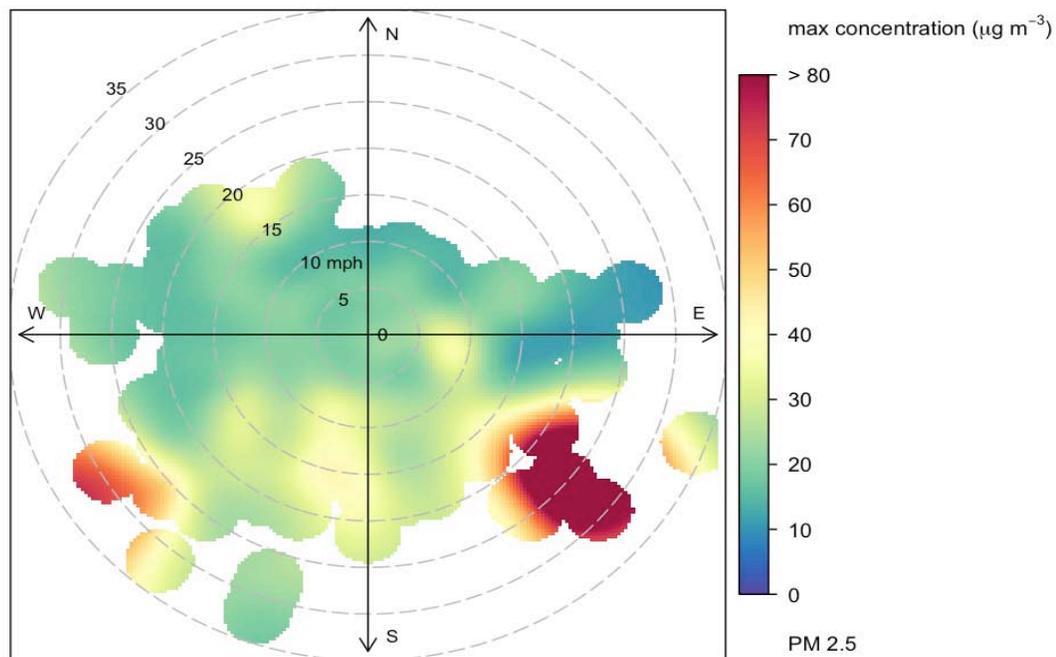


Figure 8: Counselor East (CE3) P555

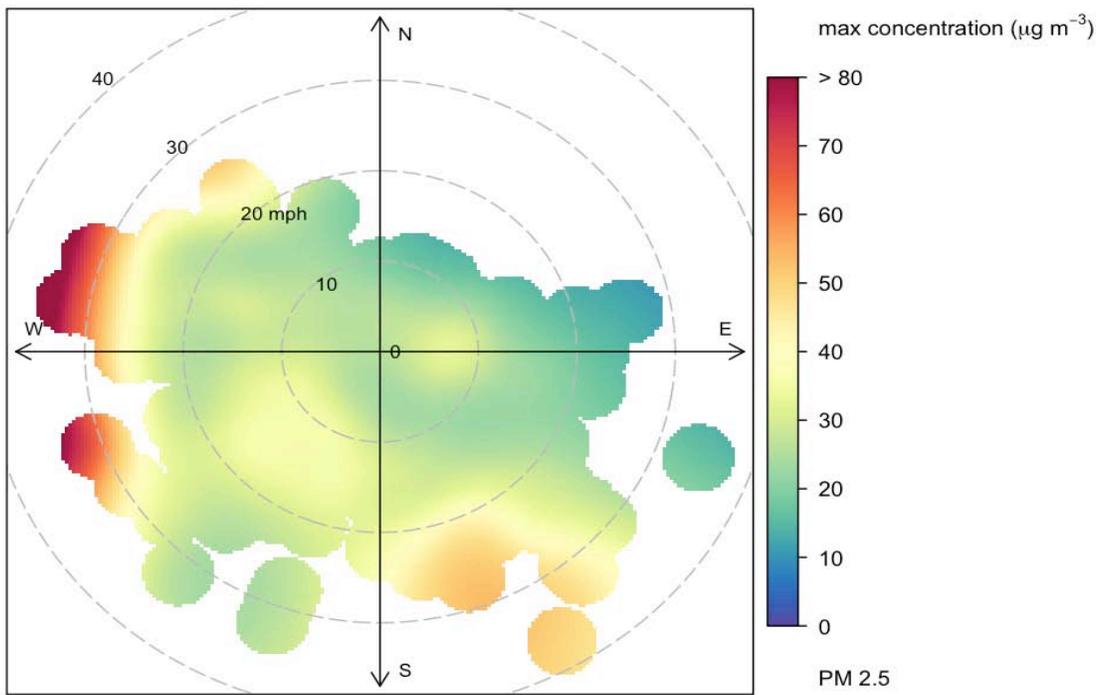


Figure 9: Counselor East (CE4) P564

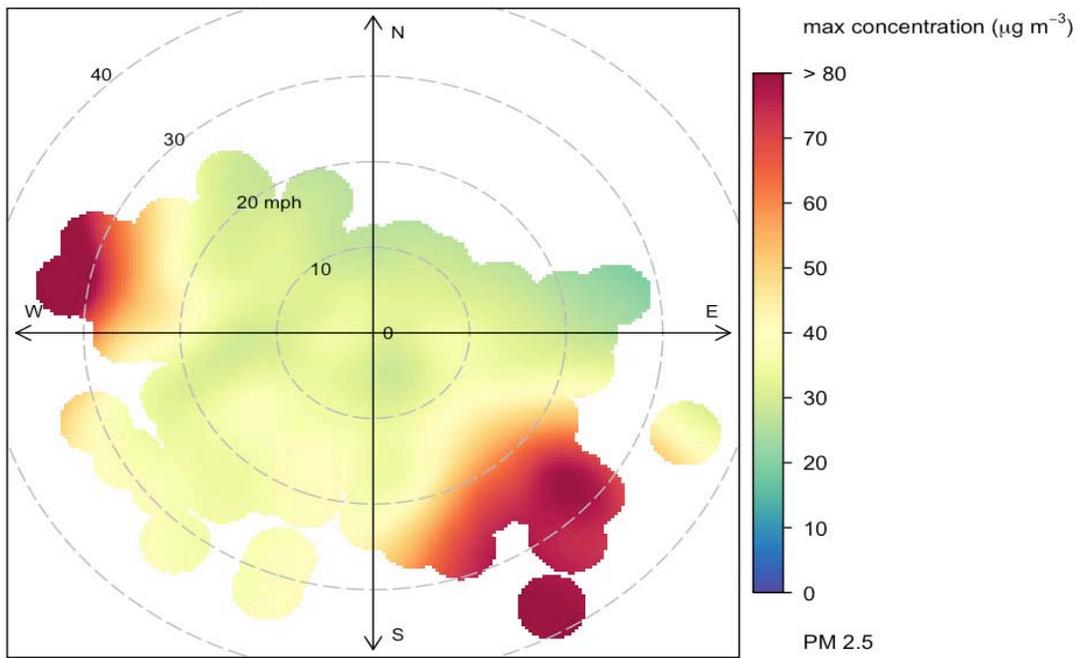


Figure 10: Counselor East (SE8) P562

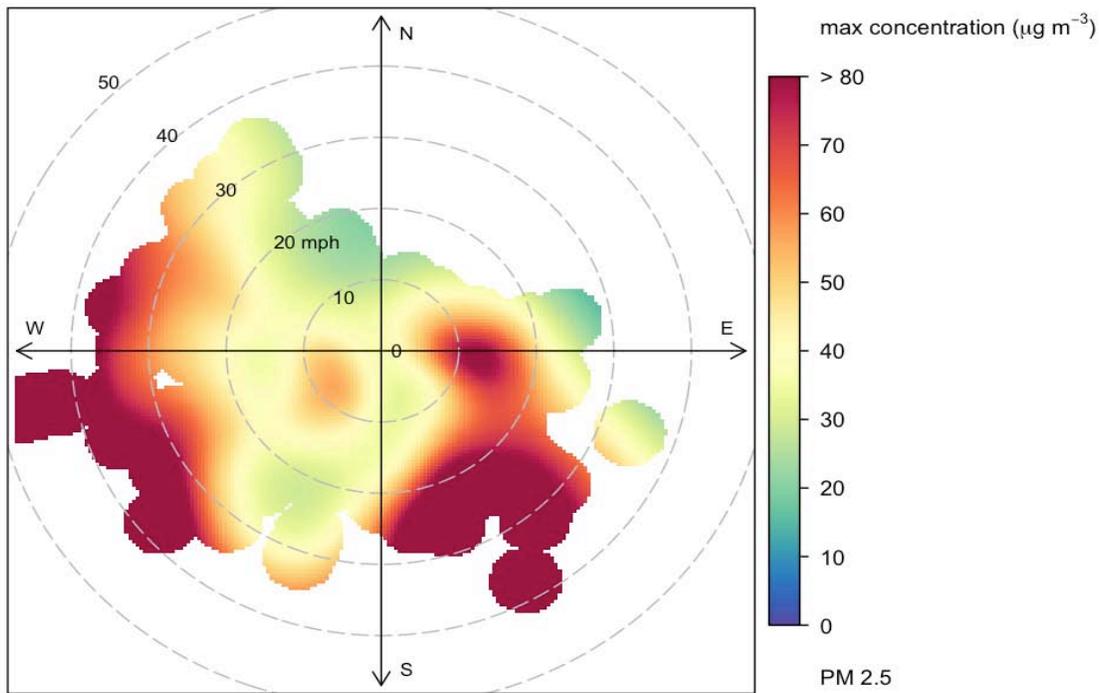


Figure 11: Counselor West (CW5) - highest recorded PM_{2.5} levels P567

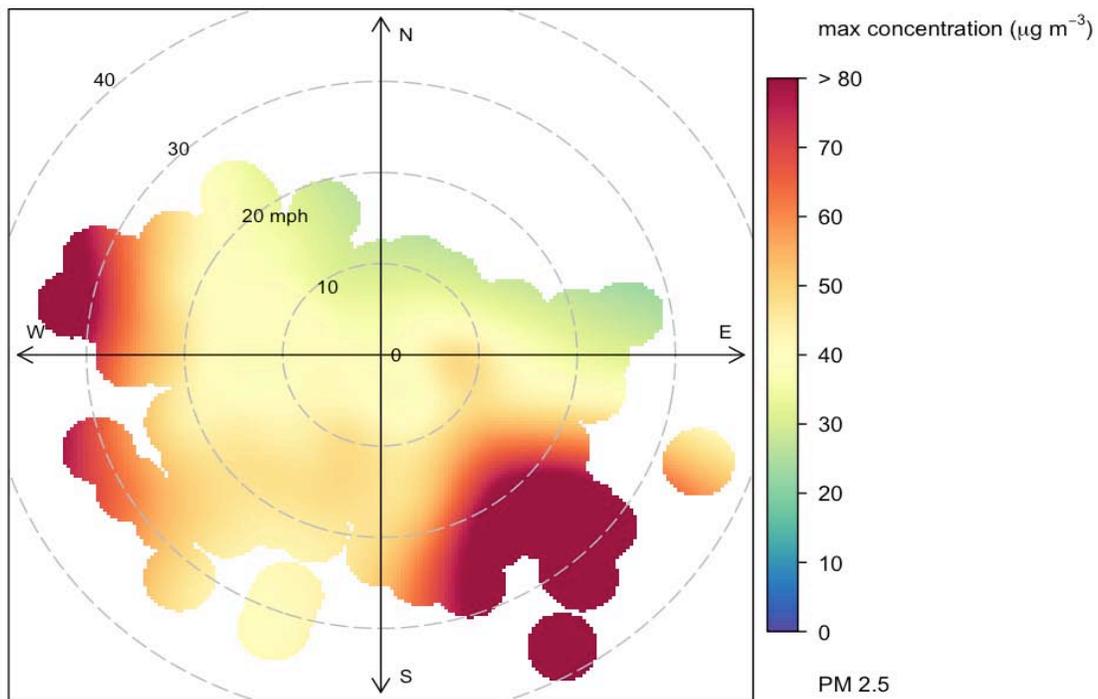


Figure 12: Counselor Highway (CCH6) P560

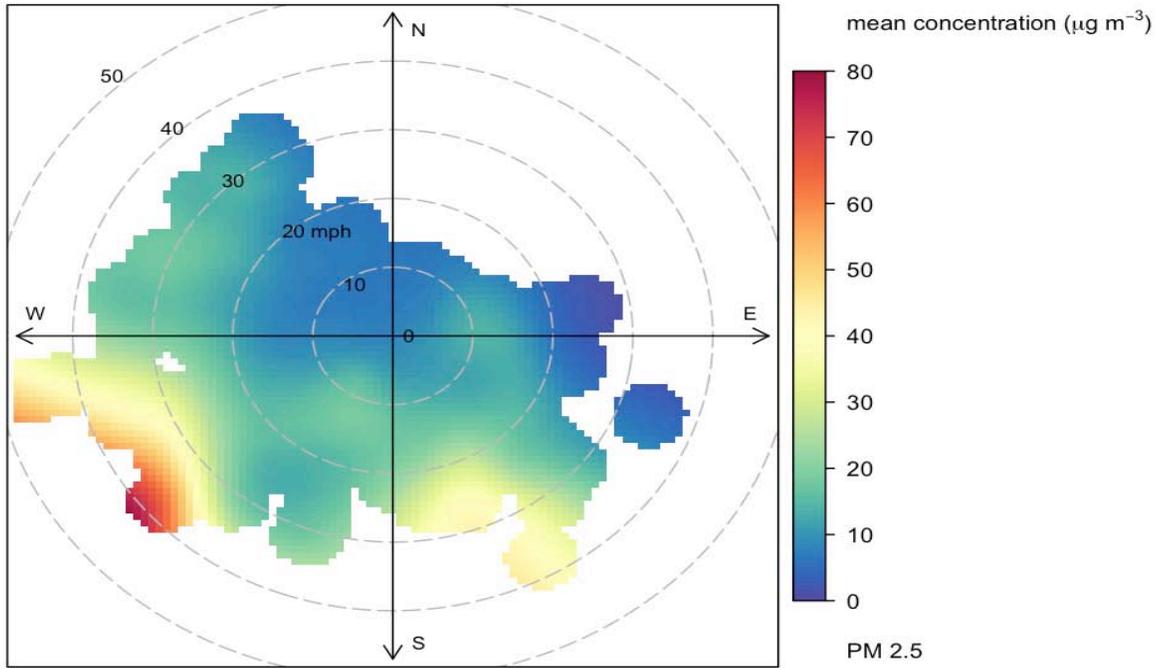


Figure13: Counselor Highway (CH7) – lowest recorded PM_{2.5} levels P572

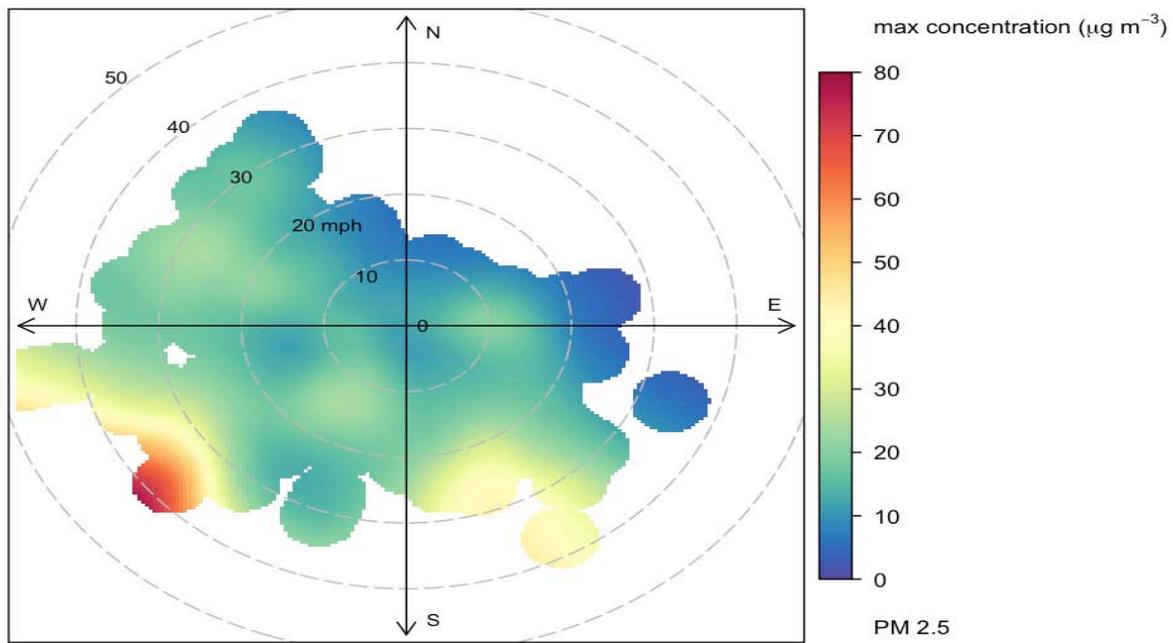


Figure 14: Counselor Highway (CH9) P570

Figures 7 to 14 are Counselor monitoring sites. EHP’s Particulate Matter Impact App pairs the Speck PM monitor results with local weather data to show which weather conditions bring higher levels of PM2.5 to each residence. If you take a closer look at Speck P567 you can see how wind direction and wind speed influence the PM 2.5 concentrations.

Each location shows a different level of exposure when paired with the weather app. Hazardous levels were reached on a few days in late April and early May when the weather was calm, cold, cloudy and snowy, keeping particulate matter and chemical emissions closer to the ground for longer periods of time.

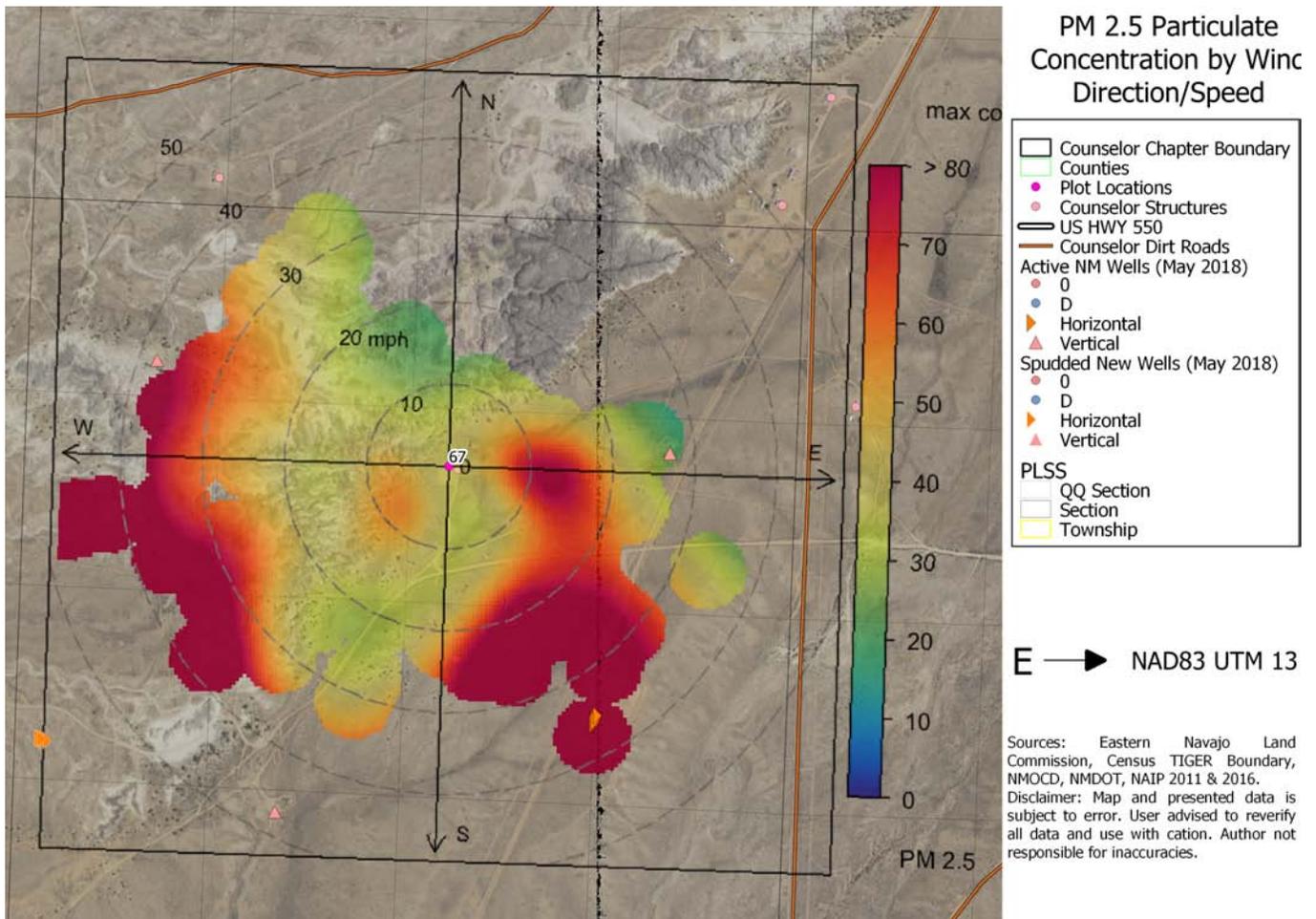


Figure 15: Close up Map of Location Speck PS67 with highest levels of PM 2.5

#67 Close up Map shows the wind speed, direction and intensity of PM 2.5 – ranging from lowest (blue) to yellow-green (which indicates the EPA level of PM 2.5 at 35 ug/m3, which can impact the respiratory health of individuals), to red (the highest level of exposure and hazardous to human health).

In this particular situation, PM 2.5 concentrations exceeding a hazardous level of 80 ug/m³ occurred from south-southwest at 30-50 mph, southeast at 20-40 mph, and east at 10-20 mph. The image above displays three important aspects of the outdoor Speck monitoring results: the direction from which the highest levels of PM_{2.5} come from; the intensity of the PM_{2.5} measurements; and the wind conditions at the times of exposure. In the image, the Speck monitor is located in the center where the lines cross. The endpoints of the lines represent the cardinal directions of North, South, East, and West with North at the top. The *intensity of PM_{2.5}* levels is shown in the range of colors from blue (low exposure) to red (high exposure). The concentric circles represent the wind speed, with low wind speed near the center and higher wind speeds further out.

Significance of Exposure

1) The episodic **intense peak exposures produced from oil/gas well emissions may only last for a few minutes to an hour in Counselor. But, such exposures can cause acute health symptoms**, even though the total exposure averaged over a 24-hour period appears acceptable and falls within a limit below a current threshold to consider action to prevent immediate health impacts.

2) Weather plays a significant role in both the number and duration of peak exposures. The period chosen to conduct air sampling fell during the spring when high winds and low precipitation is normal in Counselor. Such conditions are not conducive to sampling for air pollutants that remain in the local area and are closer to the ground (and the monitors) on calm days with either cloud cover or rain and snow events. **Testing throughout the year would yield different and more accurate results.**

3) **Evidence of exposure to hazardous levels of VOC concentrations is very short lived in the bloodstream and blood samples must be taken within hours of a symptom or time of suspected exposure.** Most communities have no facility that can provide this highly specialized blood test and residents who cannot take time to take a sample are unable to provide this crucial evidence if they try to file a formal complaint. The complaints recorded in the health section of this report have all been made in person to an HIA Committee member conducting the health survey or to a Counselor Chapter representative.

V. Counselor Chapter Health Impact Assessment (HIA)

Background

Counselor Chapter initiated the Health Impact Assessment in 2016 with a series of brief Health Impact Reports, written to document the oil well impacts being reported to chapter staff. Residents who attended chapter meetings and commented at public hearings held by Bureau of Land Management and the Navajo Nation, contributed their concerns about fracking, air pollution, traffic, accidents and illness to these reports. After several presentations to the Oil Conservation Division (EMNRD) and the Air Quality Bureau (NMED), in 2016-2017, a loosely organized committee formed in Counselor to start a formal HIA and do a community air quality study with the assistance of the Southwest Pennsylvania Environmental Health Project.

Sampling Strategy

The study focused on Counselor as the most heavily developed chapter with the highest number of active wells in the Tri-Chapter area of Counselor, Ojo Encino and Torreon. Participants in the study were landowners who lived within one mile of an active well and who volunteered to have a pair of Speck monitors placed inside and outside their home for a 32-45 day period to gather data on indoor and outdoor quality. After air sampling was completed and preliminary results released to the chapter, community residents were asked if they wanted to participate in a written health survey.

Community Health Survey

The purpose of the research, the health survey and Informed Consent forms were explained and provided to all participants. Confidentiality and the Rights as a Volunteer Participant were reviewed. A 28-question survey, listing 20 medical symptoms most commonly reported by people living near oil well operations, was completed by residents at each of the eight (8) air quality monitoring sites as well as by 57 attendees of chapter meetings in July and August of 2018 and 14 additional chapter residents who submitted survey forms directly to chapter staff following community events such as the Wellness Walk in May of 2018.

A total of 80 respondents represent 11.4 % of the population (700) of Counselor.

80 respondents were asked to indicate if they lived “near” (within 5 miles or within sight, hearing or smell) any of the following drilling or gas and oil infrastructure with the following responses:

Well Pad: 67 yes, 13 no (84% live near a well pad)

Pipeline: 53 yes, 27 no (66% live near a pipeline)

Processing Plant (refinery): 1 yes, 79 no

None lived near a Wastewater pond: 0 yes, 80 no

None lived near a Compressor station: 0 yes, 80 no

Respondents then recorded all the health symptoms they experienced in the past year since drilling began near their home.

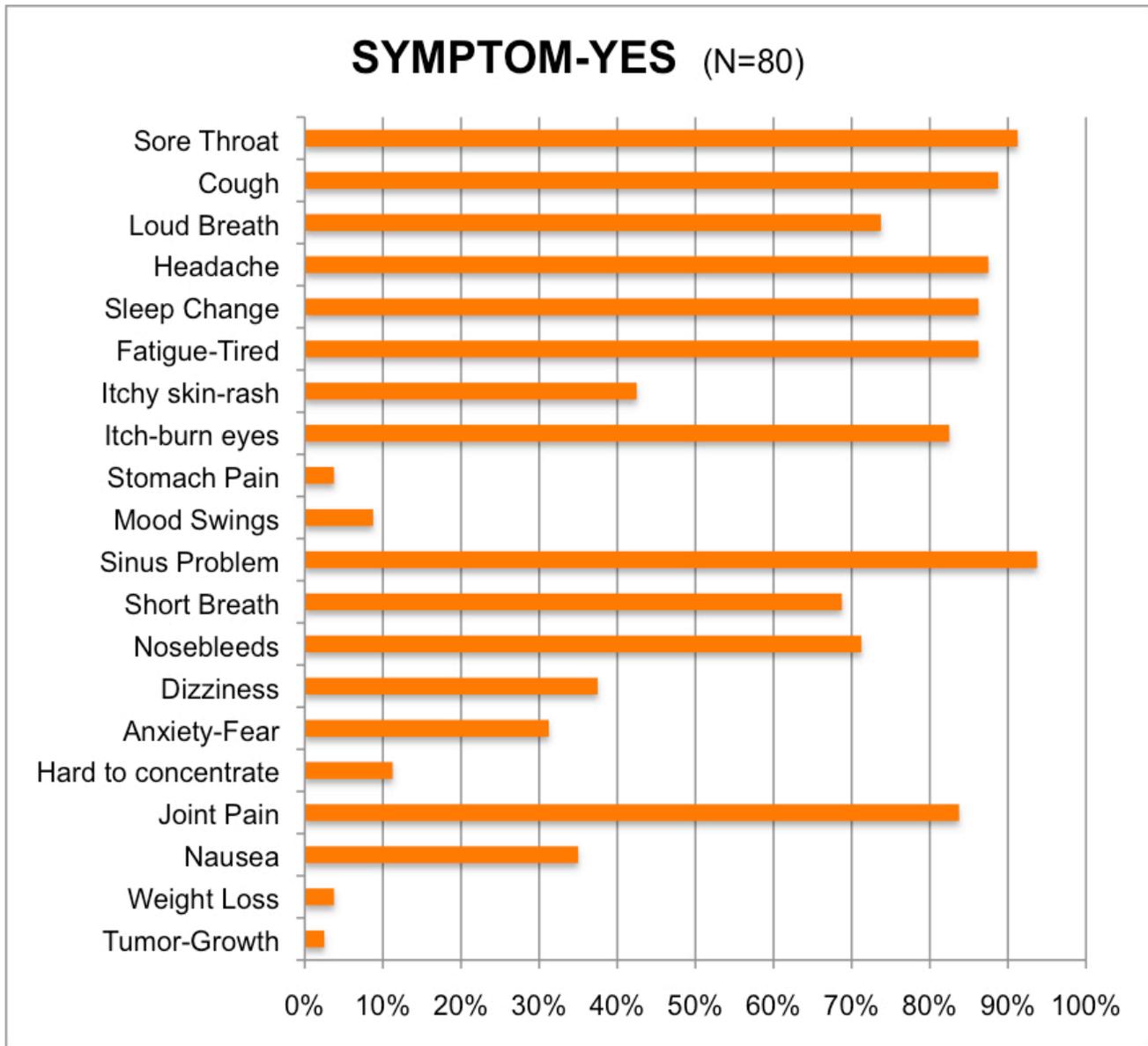


Figure 16: 20 recorded health issues with highest recorded symptom: Sinus Problem

Highest Recorded Symptoms:

- > 90% reported sinus problem (discharge, obstruction and pain)⁵ and irritated/sore throat
- 80% reported cough, headaches, itching/burning of eyes, joint pain, fatigue & sleep disturbance
- > 70% reported nosebleeds and wheezing (loud breathing)
- > 60% reported shortness of breath
- 42% reported itching of skin/rash

⁵ "Associations between Unconventional Natural Gas Development and Nasal and Sinus, Migraine Headache, and Fatigue Symptoms in Pennsylvania". Aaron W. Tustin, et al, *Environ Health Perspect* DOI: 10.1289/EHP281.

- > 30% reported dizziness, nausea and feelings of anxiety/fear
- 11% reported difficulty in concentrating
- Other less reported (< 10%) symptoms: mood changes, stomach pain, weight loss or tumors/growths
- Four Counselor health survey respondents who did not live near wells reported either no health symptoms (2 respondents), 2 symptoms (1 respondent) or 3 symptoms (1 respondent), as contrasted with the average of 11 or more symptoms reported by residents who live near wells.

Survey Results and Comparison with National Database

Over 60% of health survey respondents reported they experienced 11 out of a total of 20 listed symptoms. This a greater number of health symptoms reported by Counselor residents compared to other residents living next to gas and oil wells. The same 20 symptoms, surveyed by EHP nationally in similar communities, were reported by less than 50% of the respondents for any given symptom. Example: > 88% of Counselor respondents experienced sinus problems, sore throat and cough compared to the average of <60% of respondents in Washington County.

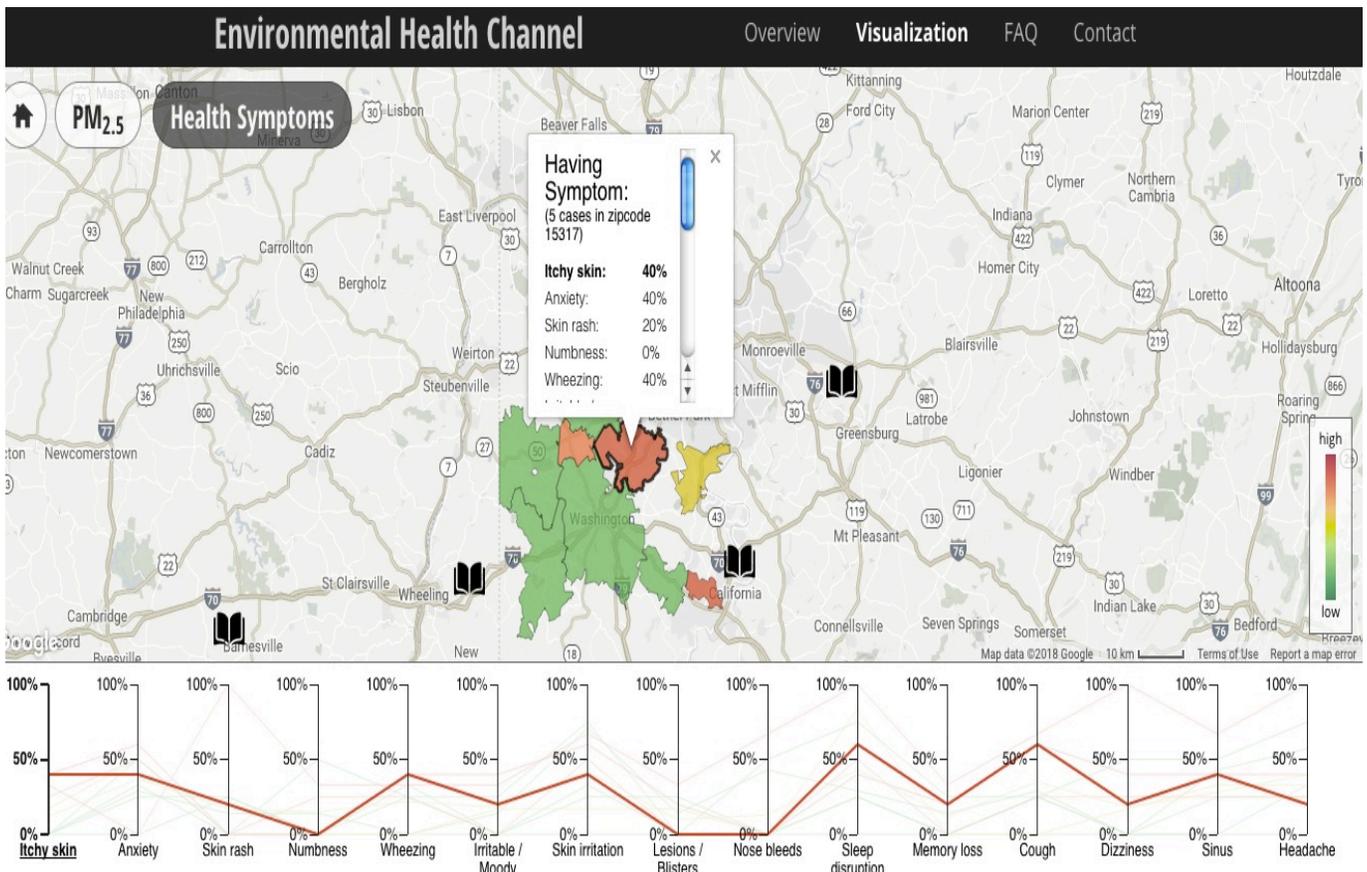
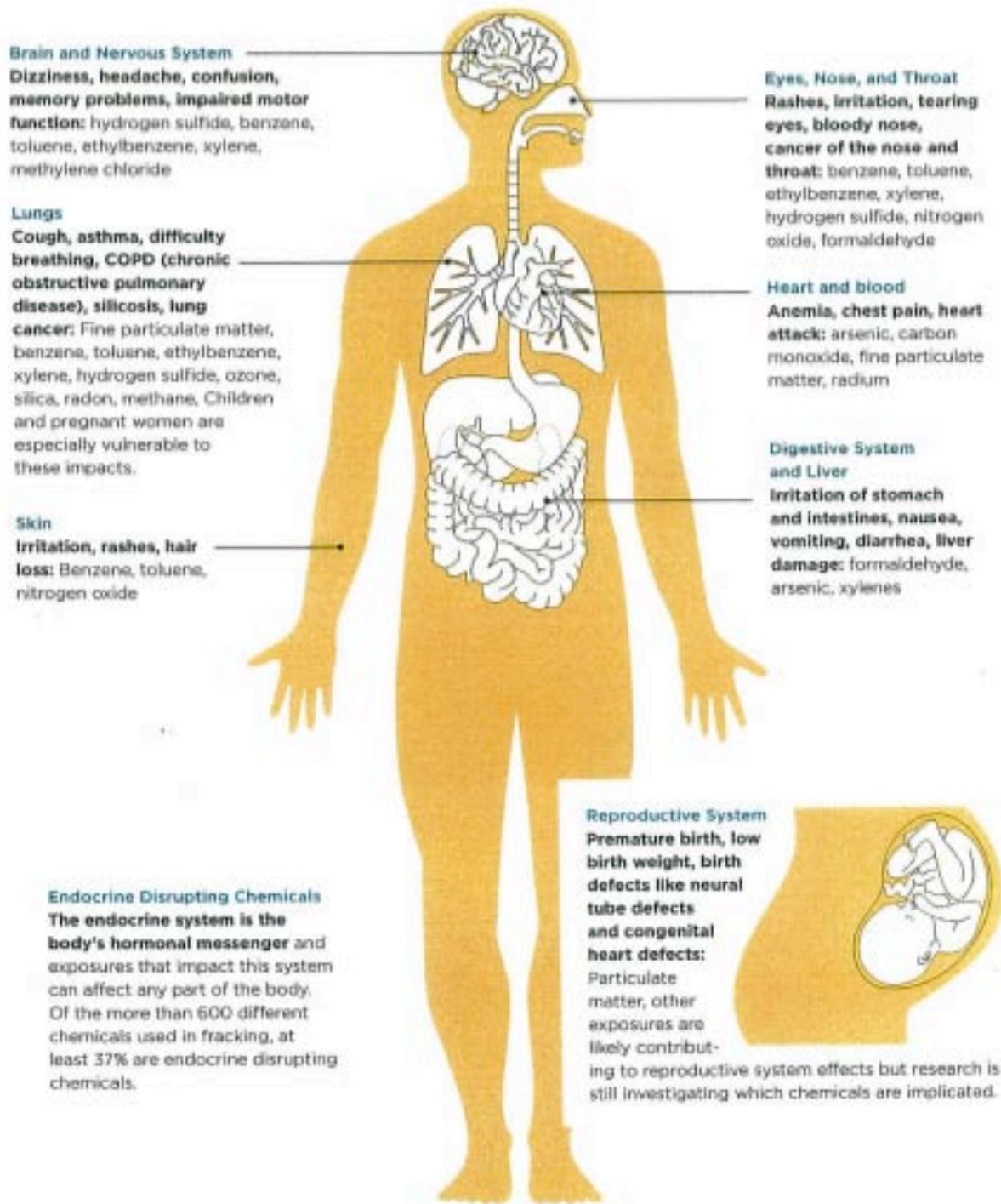


Figure 17: Environmental Health Channel screen shot of Health Symptoms recorded from residents in Washington County, Pennsylvania.



This image indicates the common symptoms and health impacts known to be linked to chemicals associated with unconventional oil and gas development, including some of the chemicals captured in air samples as part of this project.

Figure 18: Counselor Health Survey included a body graphic so respondents could draw circles around parts of the body where they experienced symptoms. 100% of 57 respondents who chose to complete this page circled the head, 92% circled the lungs and 40% circled the skin. (Graphic courtesy of Coming Clean, Inc.)

VI. SUMMARY OF RESULTS

Potential Childhood and Birth Outcomes Due to Exposure to Well Emissions

The majority of locations sampled in Counselor had higher particle concentration ($\mu\text{g}/\text{m}^3$) in their Baseline Air Quality and higher Accumulated Particle Matter ($\text{mg}/\text{m}^3/\text{day}$) than in similar locations monitored in other states. Newborns and young children are especially sensitive to well emissions and highly at risk. Exposing them to burning hydrocarbons from gas and oil well emissions puts them at greater risk than adults for both short- and long-term health effects.

Six large, well-conducted studies have been published on the effects of shale gas and oil development activity and birth outcomes. The studies found a range of overlapping outcomes associated with proximity to well pads, including low birth weight, low APGAR scores, prematurity, and neural tube defects.⁶

Children do not respond to emissions as though they are little adults. Instead:

- Children have higher respiratory rates and as a result children exposed to air contaminants breathe in more toxics per pound of body weight than adults.
- Children accumulate more toxics in their bodies than adults. Their bodies are still maturing and they cannot metabolize some toxicants as well as adults. They don't detoxify as efficiently.
- Children spend more time engaged in vigorous activity outside, increasing their exposures.
- Children's brains are still developing. Many toxic agents are known to interfere with developmental processes within the brain.

Children under the age of 9 years make up approximately 31% of the population of Counselor. Their well-being and future health and development is the highest rated concern of Counselor residents.

Health Effects from Exposure to Volatile Organic Compounds (VOCs)

VOCs, present at gas and oil wells, are a varied group of compounds that can range from having no known health effects to being highly toxic. **Short-term exposure can cause eye and respiratory tract irritation, headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reaction, nausea, and memory impairment or inability to concentrate.** Long-term effects include loss of coordination and damage to the liver, kidney, and central nervous system.

The above symptoms caused by episodic exposure to VOCs were recorded by > 80% of Counselor residents that participated in the health surveys conducted from May through August 2018 by the Counselor HIA Committee.

Further air quality testing and voluntary on site blood sampling from residents, for VOC levels, is needed to determine the actual degree of individual exposure and potential harm.

⁶ Hu, Howard, James Shine, and Robert O. Wright. "The Challenge Posed to Children's Health by Mixtures of Toxic Waste: The Tar Creek Superfund Site as a Case Study." *Pediatric Clinics of North America* 54, no.1 (February 2007): 155-175, x. doi: 10.1016/j.pcl.2006.11.009.

VII. Community Recommendations

Mitigation Measures Recommended for Community Health and Safety

The Counselor HIA Committee has worked closely for several years with the residents of Counselor and in 2018 with the Environmental Health Project (EHP), a public health organization working at the forefront of the nation-wide response to health impacts from unconventional oil and gas development (UOGD)

Based on 1) written comments, resolutions and memorials from Navajo Chapters and other elected leaders and representatives from the Navajo Nation and New Mexico Legislature; 2) results from the air monitoring project conducted by the Counselor HIA Committee; 3) health surveys completed by the Counselor Chapter; 4) and national research conducted by organizations and academics that have published in peer-reviewed literature, this report recommends the following mitigation measures to protect public health:

1. The most effective method to prevent toxic exposures for nearby residents is to trap emissions at the source. Emissions should be contained on all polluting equipment including wellheads, tanks, compressors, and pipeline valves.

2. Continuously monitor air emissions at UOGD sites for volatile organic compounds (VOCs), formaldehyde and fine particulate matter (PM_{2.5}). Monitoring should provide minute-by-minute data and the data should be analyzed to show the frequency, intensity and duration of peak emissions in addition to long term averaged exposures. These peak periods can cause dangerously high exposures for residents, especially children and individuals with pre-existing conditions, and are important health data for medical diagnosis.

3. Continuously monitor for VOCs, formaldehyde and PM at nearby schools, daycares, nursing homes where health-sensitive individuals are located. Develop emergency plans for these locations in the event of high exposure scenarios.

4. Provide indoor air filters for residents within 1/2 mile of UOGD sites. Include the provision of replaceable filters and maintenance for the indoor air equipment.

5. Establish a setback distance minimum of 1/2 mile (2640 feet) from smaller shale gas facilities, such as wells, that emit 100 to 500 grams/hour.

6. Establish a setback distance minimum of 1 1/4 mile (6600 feet) for gas processing plants and large compressor complexes whose emissions exceed 1000 grams/hour.

7. Require windbreaks around UOGD sites that are located on plateaus, plains or other geographic areas that do not provide physical barriers between sites and residential areas.

In addition:

- ◆ Complete the recommended steps on the HIA Assessment Checklist to adequately inform community residents of all the known and unknown risks they are being asked to assume.
- ◆ Perform an in-depth air emission projection to establish the local population health risk to cumulative effects before additional wells are drilled.
- ◆ Require best practices to ensure that effective emissions control measures are kept up to date.
- ◆ ALERT residents via the Chapter ALERT website of large emission events.
- ◆ Put emergency plans in place in case of evacuation.
- ◆ Institute a monitoring strategy at well sites and key public locations and make the data public on the Chapter website.
- ◆ Institute a health-monitoring registry at the local Indian Health Clinic to include short- and long-term effects.
- ◆ Facilitate voluntary blood sampling by providing “on-site” facility (within a one-hour drive) that can test exposed individuals for VOC levels and monitor symptoms and treatments.

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APPENDICES

Appendix 1

ALS Environmental: Report #1806078, NCP-Navajo Community Project (QC sample results and case narrative) June 18, 2018. Pgs. 1-25; ALS Environmental: Report 18051137. June 13, 2018. Pgs.1-12.

Appendix 2

Southwest Pennsylvania Environmental Health Project Report: "Counselor Chapter Air Quality Assessment Results: Particulate Matter (PM_{2.5}) and Volatile Organic Compounds (VOCs)", (August 3, 2018) pgs. 1-14

Appendix 3

Navajo Nation Environmental Protection Agency Air Quality Control Program "Ambient Air Monitoring, Counselor, NM" (April 14, 2016-May 18, 2017) pg. 1-2

Appendix 4

New Health Issues for Counselor – Produced Water & Water Monitoring

ACRONYMS

US EPA	United State Department of Environmental Protection
ATSDR	Agency for Toxic Substances and Disease Registry of the Centers for Disease Control and Prevention
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limits
REL	Recommended exposure limit $\mu\text{g}/\text{m}^3$
	Micrograms per cubic meter → air quality measurement
ppm	parts per million
ppb	parts per billion